

Hydrate management for the future

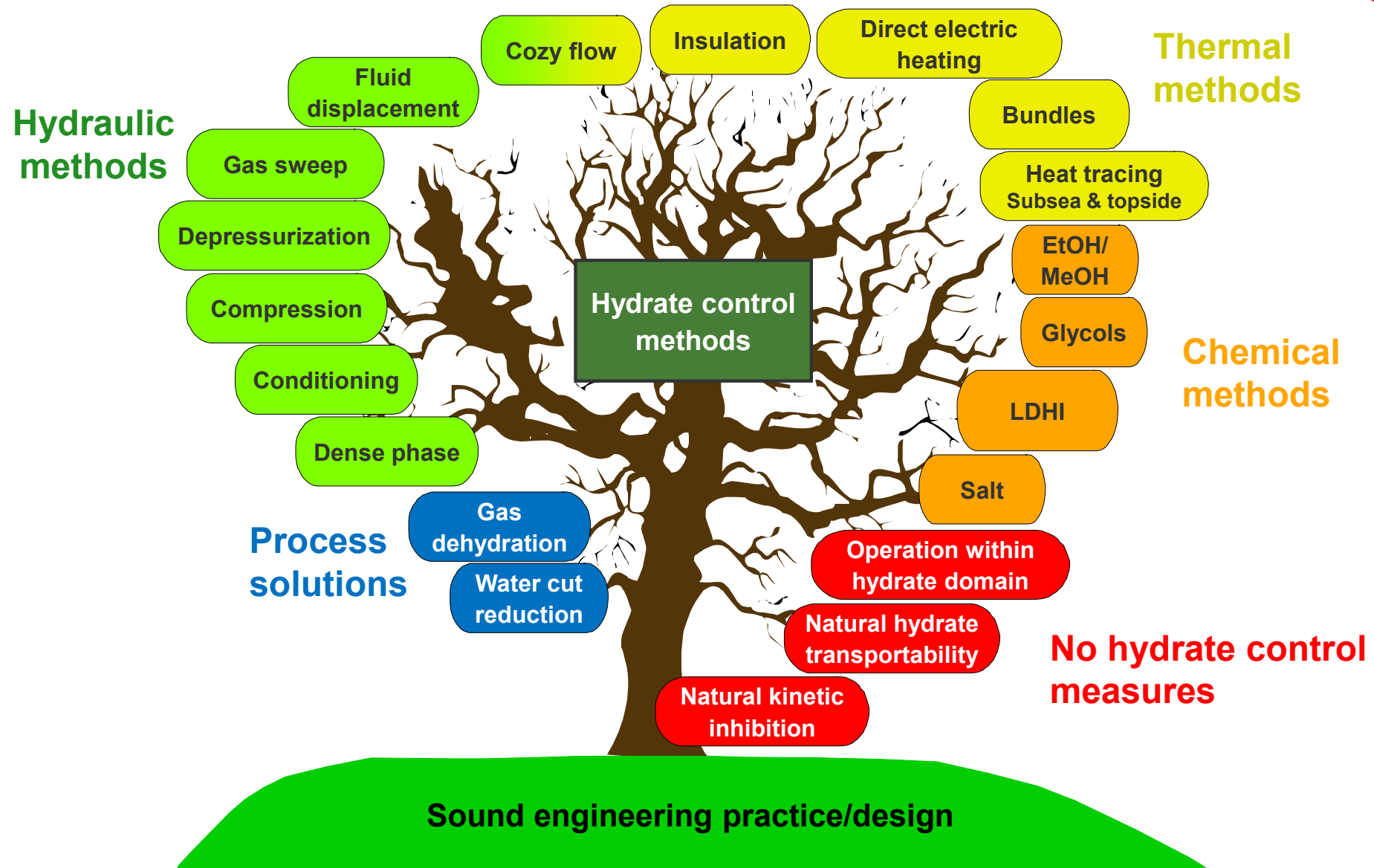
FORCE Webinar: Hydrate Management Strategies For Unlocking Production from Marginal Subsea Tiebacks.

Equinor presentation by Frode Nygård, 30.04.26.

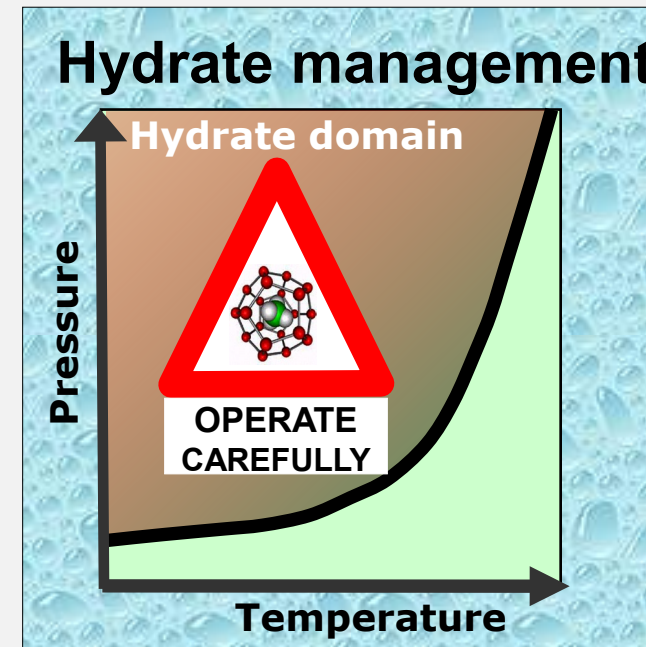
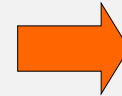
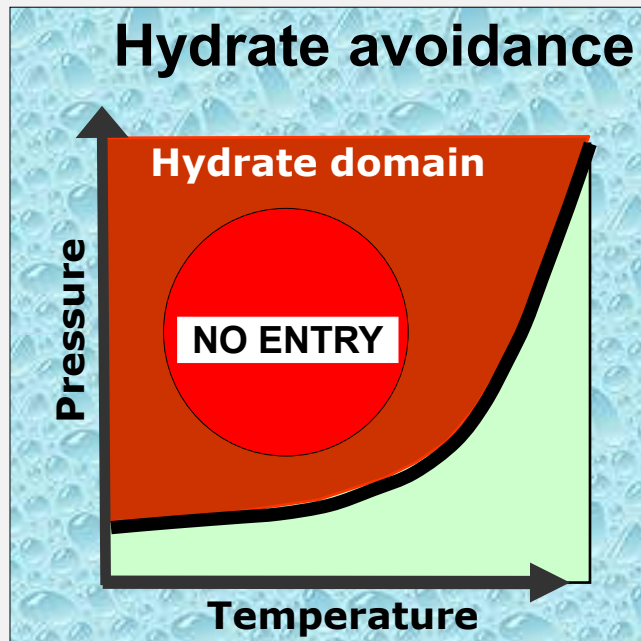
Contents

- General on hydrate management
- New hydrate risk management tool
 - WaterLock Method
 - Online hydrate indicator
- Integration of “WaterLock” method into the “online hydrate indicator” is an ongoing activity

Hydrate control methods



Hydrate control approach



Hydrate control of flow lines

Example case: No active measures during shutdown – gas dominated flow

When the water content is low (typically < 10 %- 20 % and total volume below a given limit), no hydrate control measures are possible.

- **Do-nothing**: Careful operation in the hydrate region. We accept hydrates, but not a hydrate plug
- Can be obtained after a **gas sweeping** operation

Case by case approach and needs backing from experimental tests or/and operational experience (system specific)

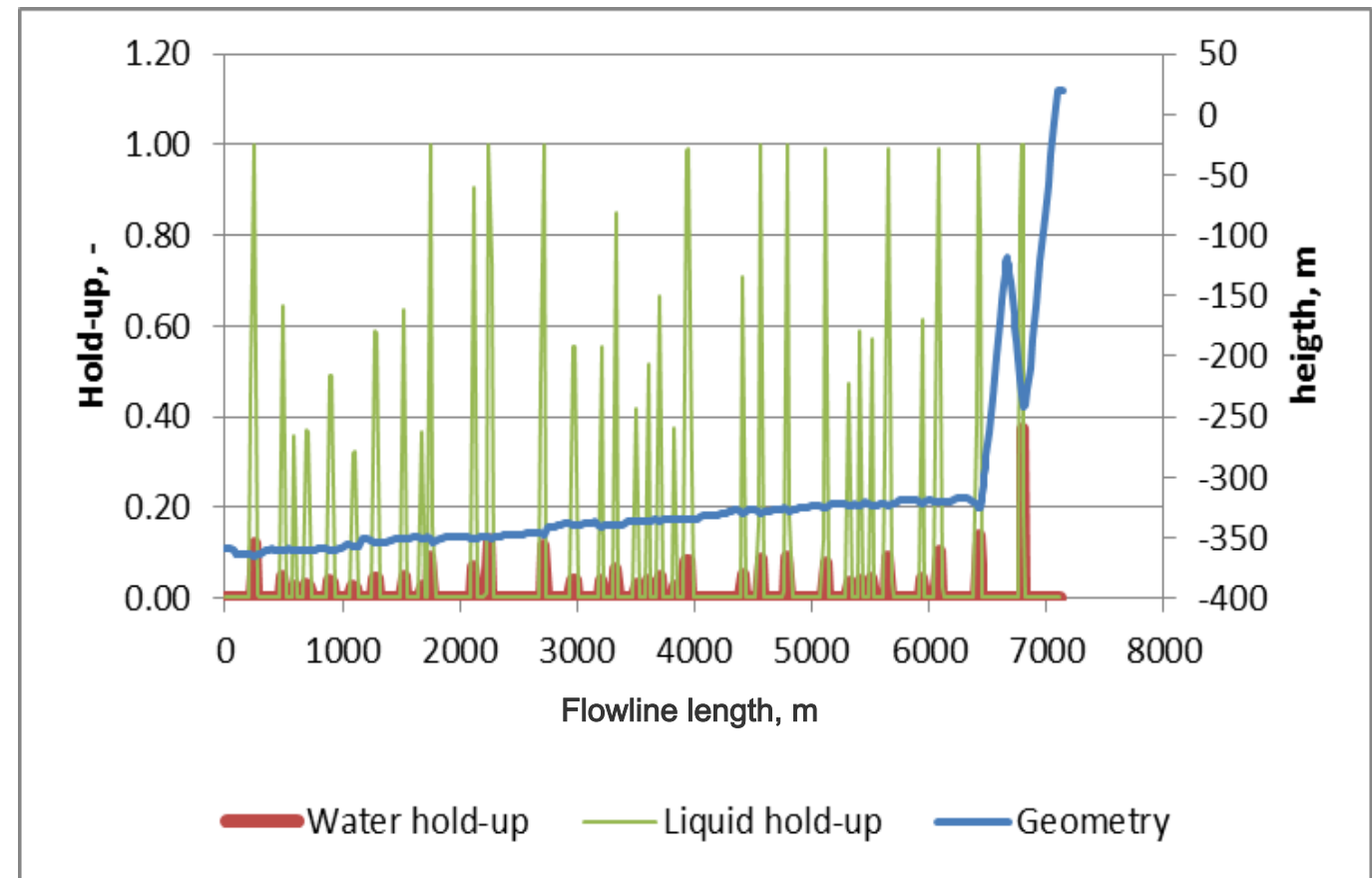
- How many low points?
- How close are low points?
- How much water in the system?

Hydrates can be formed which may require chemical injection upstream topside choke.

No Touch Time is normally set to between 7-21 days.

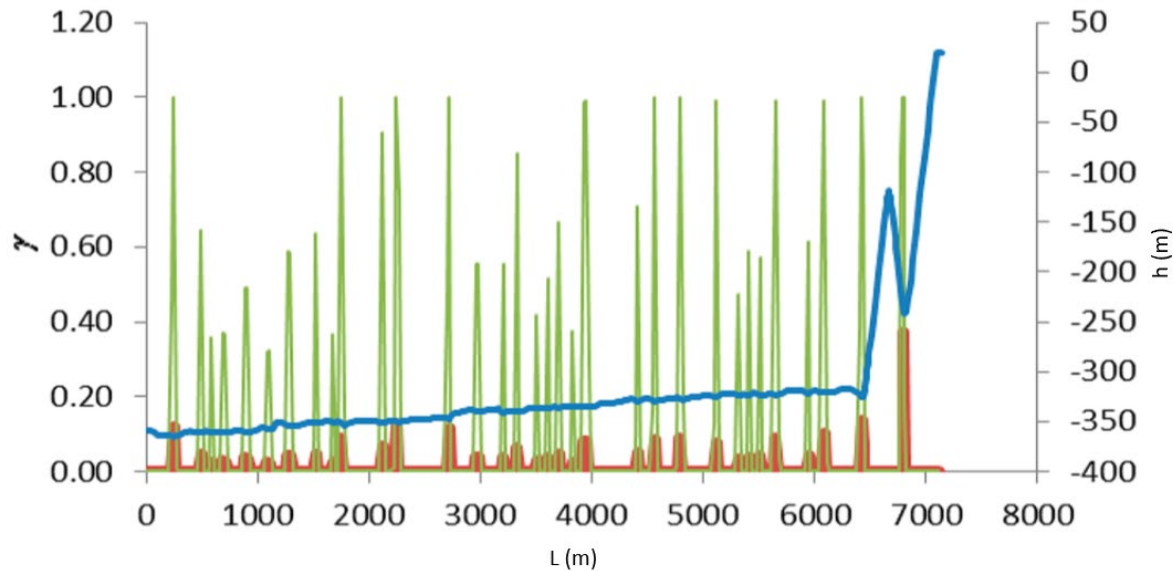
- Transients (pressure pulsations) in the system will redistribute water, and enhances fluid mixing

Cost and CO2 savings for unplanned shutdowns

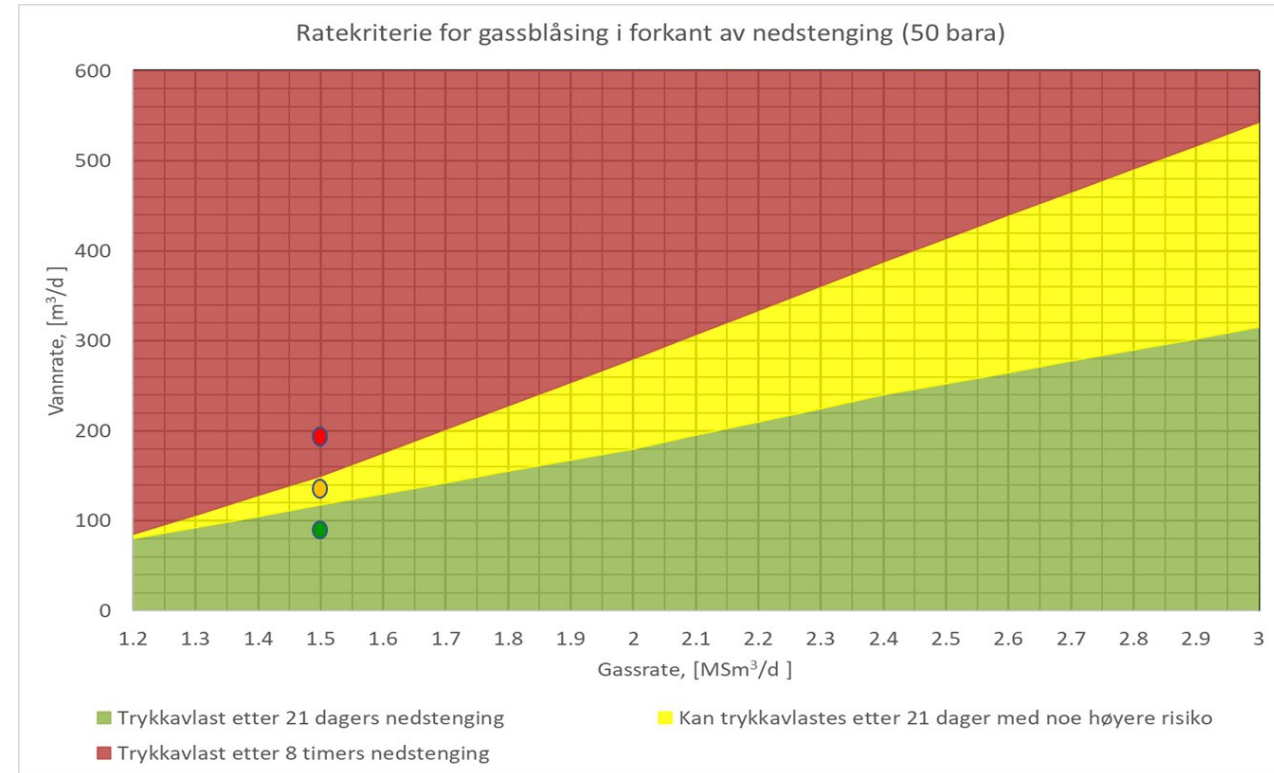


Introduction: Former best practice of “Do-nothing” strategy

Existing hydrate risk maps based on OLGA water hold -up values directly

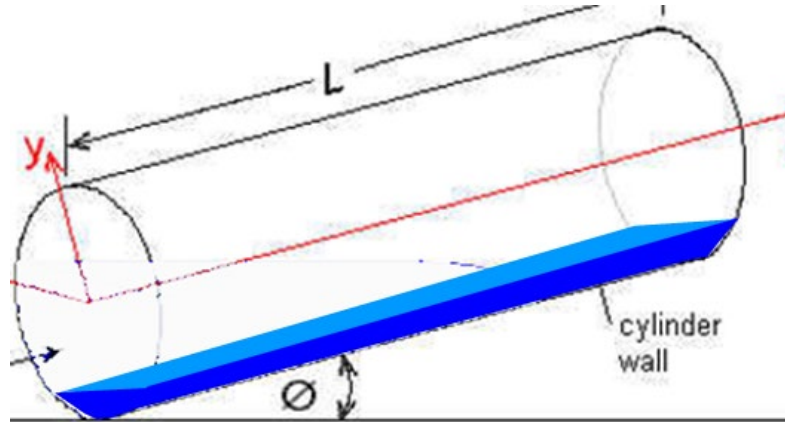


Simulator/OLGA Water Hold -up (SWH)

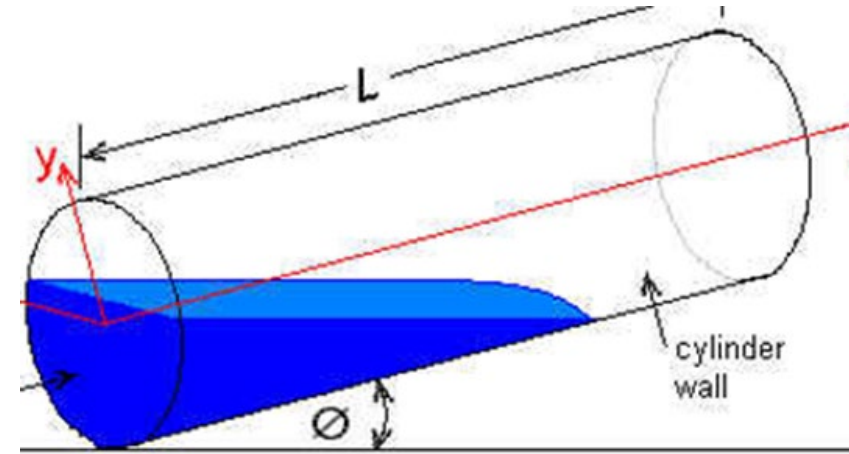


- Current criterion: **OLGA-WH_{shut-in} < 20 vol%** for choosing “Do-nothing” strategy
- Statement: OLGA-WH value is a weak parameter when assessing hydrate risk

Introduction: Why is OLGA-WH a weak parameter?



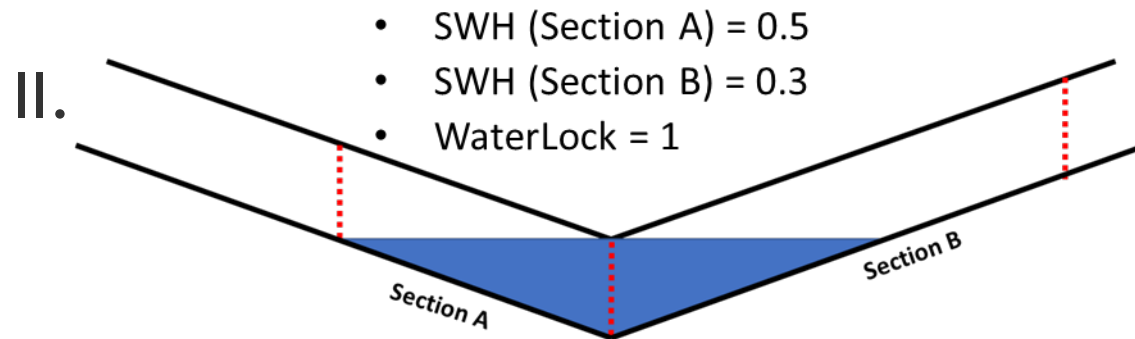
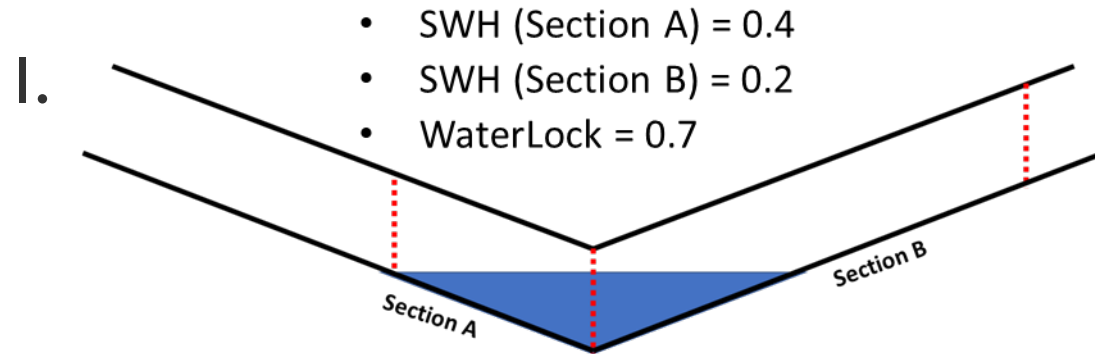
Simulator/OLGA Water Hold-up (**SWH**) during shut-in as reported in a simulation software.



Actual water distribution in a low point.

- OLGA/Simulator Water Hold-up is an averaged water hold-up over the entire section connected to a low point
- Suggested solution: **The WaterLock Method** evaluates the actual water coverage (Risk indicator Waterlock) in low points

The WaterLock Method



- SWH (e.g. OLGA water hold-up) gives no clear picture of the difference in hydrate risk between Scenario I and II.

- **WaterLock**
 - space is available for gas to pass.
 - gas needs to bubble through the water phase to pass.

Actual water distribution in a low point as assessed in the WaterLock method. Red dashed lines define the sections.

The WaterLock Software Tool

- The WaterLock software tool (Python code) is developed for accommodating the WaterLock method.
 - Code inputs:
 - Flowline geometry (preferably the as-laid profile)
 - Water and liquid content along the flowline from e.g. OLGA (following best practice wrt. section length etc. for such type of simulations).
- The code identifies all low points and redistributes liquid in chosen flowline profile => calculates risk indicators (RI)

Risk indicators (RI):

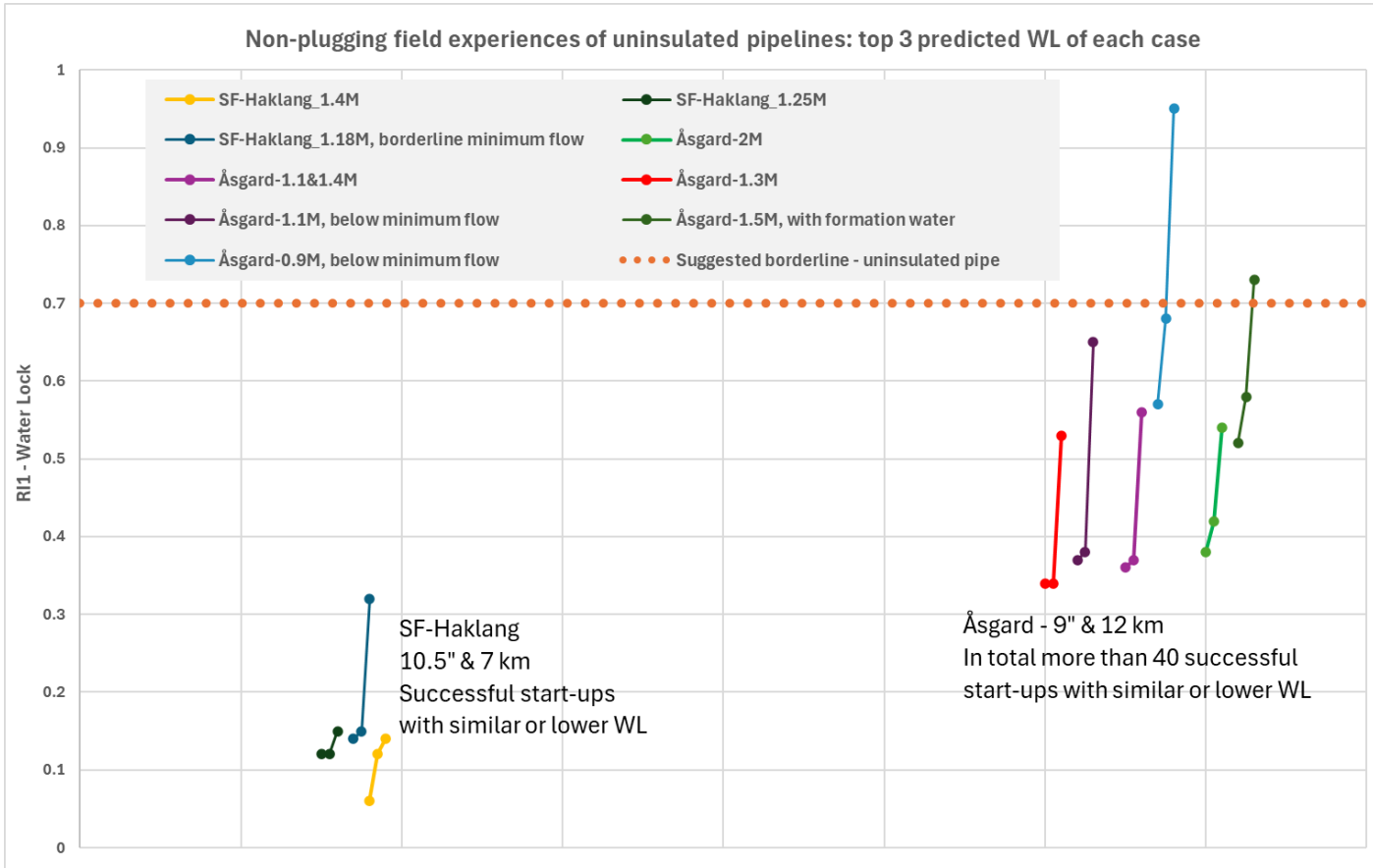
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- WaterLock = 1
- Water wetted upper wall
- Section C
- Section D
- The diagram shows a V-shaped channel cross-section. The water level is indicated by a horizontal line. The area of the channel filled with water is shaded blue. The upper walls of the channel are labeled 'Section C' and 'Section D'. A red dashed line indicates the water level. Blue arrows point to the upper walls with the text 'Water wetted upper wall'.

Figure 10 consists of two vertically stacked plots. The top plot shows the 'height below sea level (m)' on the y-axis (ranging from -362.5 to -380.0) against 'Horizontal length from the inlet (m)' on the x-axis (ranging from 0 to 25000). It displays four data series: 'Waterlock (-)' (black line), 'Original liquid input' (red line), 'Adjusted topology' (blue line), and 'Medium smoothing of the topology' (green line). The bottom plot shows the 'Risk indicator #1' on the y-axis (ranging from 0.0 to 1.0) against the 'Stretch number' on the x-axis (ranging from 0 to 150). The risk indicator is represented by a red bar chart.

☐ *Water wetted length in the stretches*

[View](#)

Results & applications: Waterlock of uninsulated flowlines

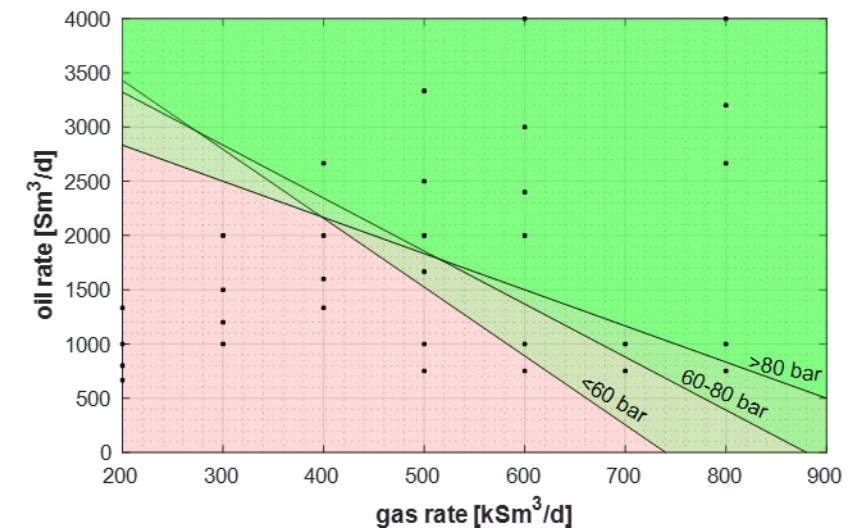
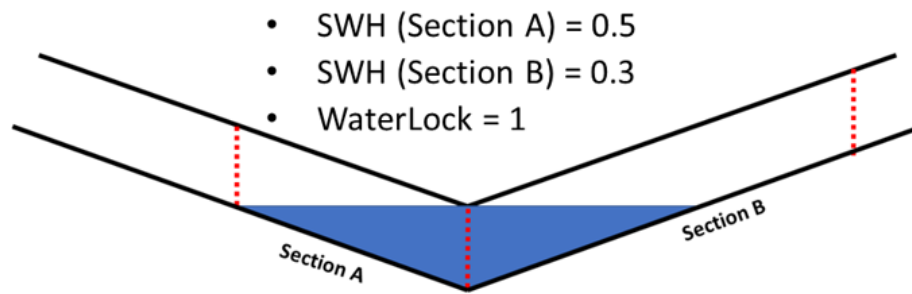


Waterlock estimations for two gas condensate flowlines and suggested Waterlock criterion for “Do-nothing” candidate of uninsulated flowlines.

- All field cases with RI-Waterlock < 0.7 started up **successfully**.
- Field cases with Waterlock > 0.7 is often below defined minimum flow.
- RI-Waterlock < 0.7 is suggested as the major criterion for the **“Do-nothing” strategy** of uninsulated flowlines.
- Other RIs could be important too, need to be considered case by case, e.g. effective water slug length & water cut

Conclusions on the WaterLock software tool

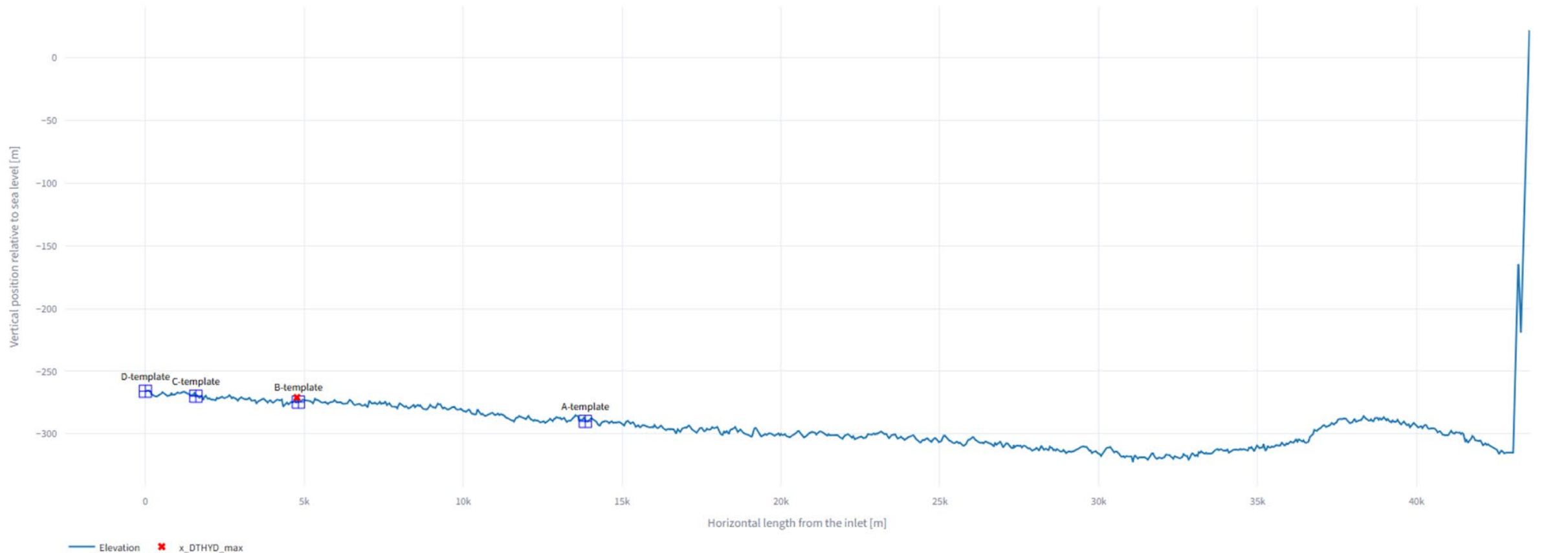
- A new tool for hydrate plugging risk assessment in flowlines
- Two versions developed: a stand-alone (GUI) and an online version
- Post-analysis of OLGA results (redistributing water & calculating plugging risk indicators)
- Better & more plugging risk indicators (more physical) compared to parameters from OLGA
- Very flexible: both predefined risk indicators & user self-defined indicators
- Useful for making new risk maps/guidelines and online plugging risk assessment/management
- Have already had some successful field applications



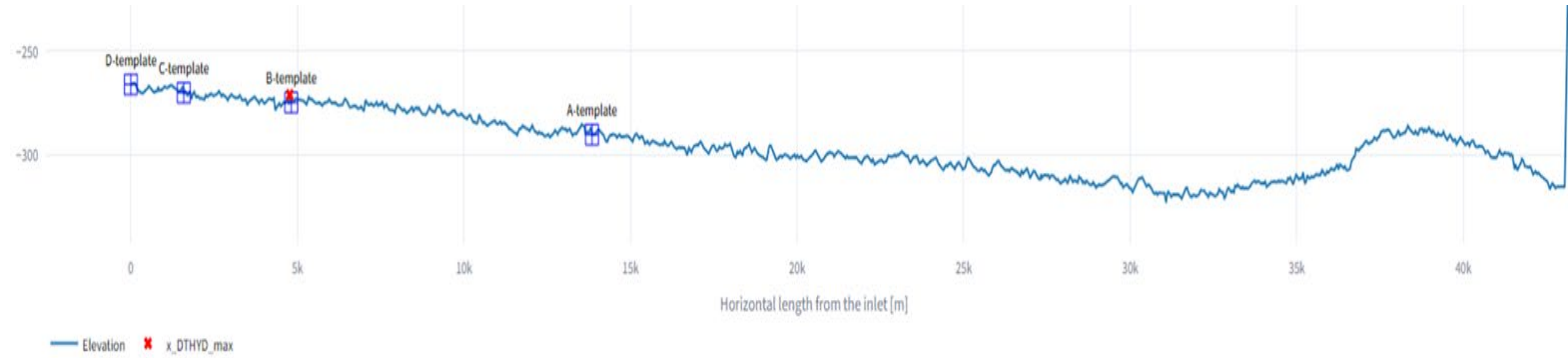
Live Hydrate Indicators

- Measured inlet/outlet pressures, temperatures and flow rates as input.
- Run OLGA once every hour to get new update status
- Calculate DTHYD based on pressure profile and temperature profile along pipeline systems

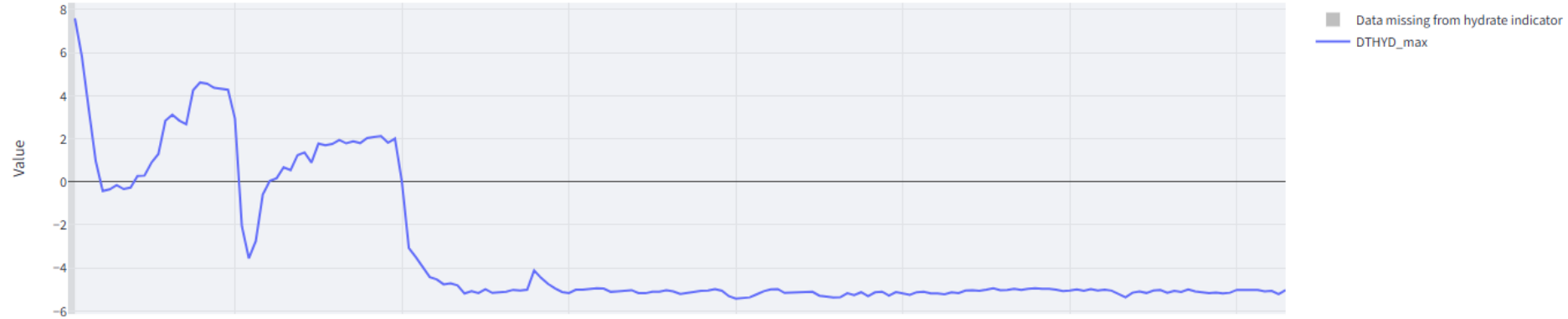
Pipeline profile



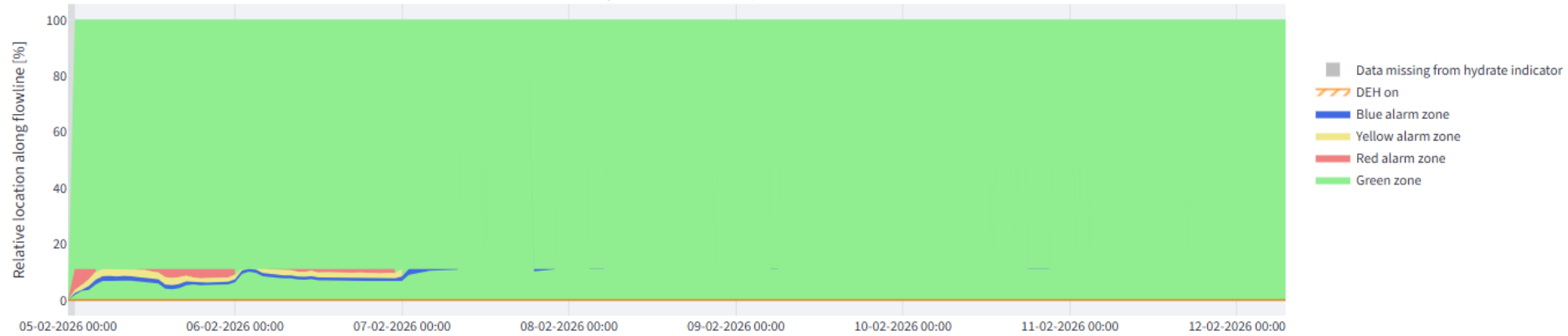
DTHYD visualizations



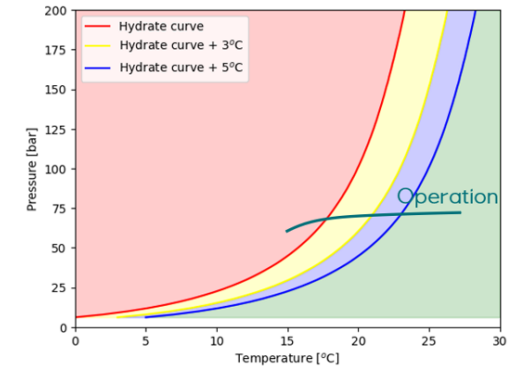
Hydrate risk



Hydrate risk heatmap



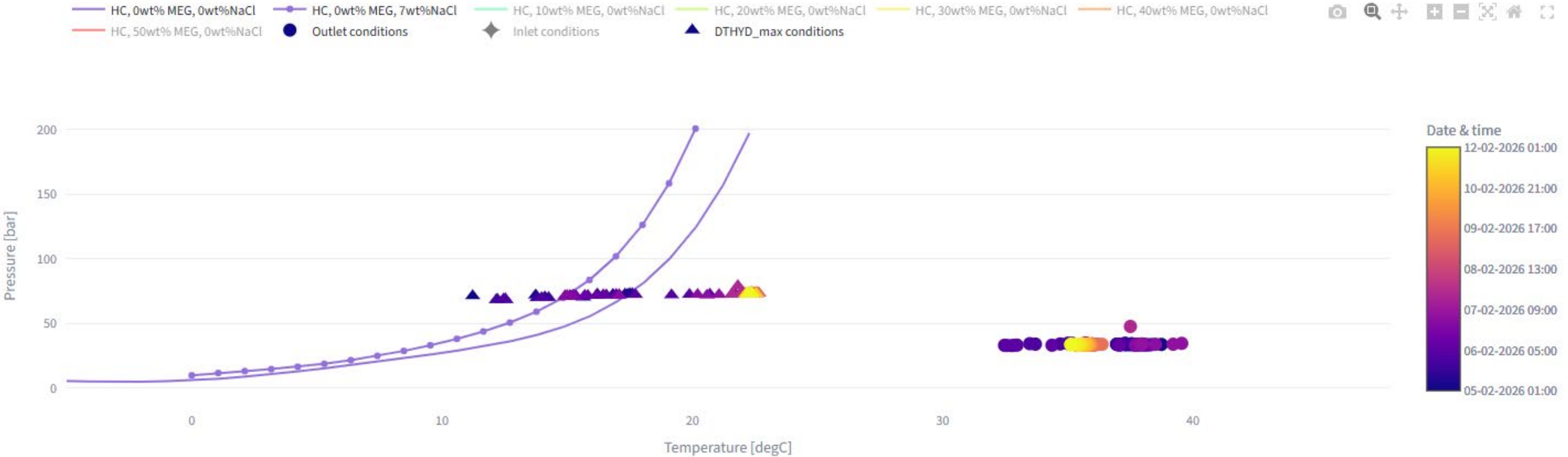
Alarm zones



Actual hydrate curves compared with max DTHYD and outlet conditions

Hydrate curve

☐ Mark shutin points



Live Hydrate Indicator - features under development

- Run OLGA shutin simulation from actual measured condition
 - Use the WaterLock tool on the live system to evaluate water and liquid management during shutin
 - With possibility to upload as-laid profiles and drain the simulated liquid (from the simplified geometry in the simulation file) into the aslaid profile.
- Cool down monitoring
- MEG-injection calculator
- Batch-tracking functionality, currently focus on MEG tracking

Waterlock risk along the flowline geometry

Pipeline PPL profile & Waterlock in major low points

